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ABSTRACT

Described in this manual is the use of insecticides, fungicides, and herbicides in forestry. Both diseases and insects found in hardwoods and conifers are covered. Detailed information is given on methods of herbicide application. Finally, five important environmental considerations are given. (BB)

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Applicator Training Manual for:

FOREST PEST CONTROL

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UNIVERSITY OF KENTUCKY · COLLEGE OF AGRICULTURE · COOPERATIVE EXTENSION SERVICE
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FOREWORD

This training manual is intended to provide you with the information you will need to meet the standards of the Environmental Protection Agency for pesticide certification and to prepare you to take an examination given by the State Department of Natural Resources and Environmental Protection based on this manual. It is not intended that this training will provide you with all the information you need for effective forest pest control. Additional information in the form of publications and short courses can be obtained from the Cooperative Extension Service.

Names of chemicals mentioned in this manual were registered for the specific use described in 1975. Others may have been registered for the same use but may have been unintentionally omitted. Registration of chemicals is a rapidly changing situation, and the pesticide operator must keep up with new registrations as well as the cancellation of registrations.

INTRODUCTION

Kentucky is a transition zone between northern and southern forests. The blending of northern and southern species makes our state's forests rich with a wide variety and number of tree species. Possibly a hundred distinct species of trees are native to the state, and about half of these have some commercial value and use. About 45% of the state's land surface, or more than 11,000,000 acres, is clothed with trees.

Deciduous or hardwood forests predominate. More than 90% of the merchantable volume of timber is hardwood with various species of oak making up about one-half of the timber resource. The hickories, yellow-poplar, beech, and the maples are important, and black walnut is important primarily because of its high value per unit of wood.

The species of hardwood found on any given parcel of land will vary greatly not only with the geographic location in the state, but with site factors such as soil depth, soil moisture, soil structure, and aspect. Past land use, past harvesting practices, and fire history also enter into the current species composition. Certain tree associations appear more often and are classified as forest types. The principle hardwood forest types recognized by the U. S. Forest Service in a survey of the forest resource in Kentucky are the oak-hickory type, covering more than 4,700,000 acres, and mixed hardwoods, with slightly more than 4,000,000 acres. Other hardwood forest types which may be very important locally, but are relatively minor in the state, are white oak, maple-beech, oak-gum-cypress, and elm-ash-cottonwood.

The conifers, including the pines, redcedar, hemlock, and cypress, represent less than 10% of the forest resource. Redcedar and Virginia pine have the widest distribution. While relatively unimportant to the state as a whole, locally they have considerable commercial importance. The pines are particularly important in and near the cliff section of the Cumberland Plateau in eastern Kentucky. The conifers are also important to many people because of forest plantations, consisting of various species of pine, which have been established throughout the state.

The forest resource is the raw material base for the forest industry in Kentucky. The management of the forest resource is not only important for wood products but for water, wildlife, and recreation. Pesticides play a role in the intensive management of this resource.

TYPES OF PESTICIDES

There are three major types of pesticides used in forestry practices in Kentucky. They are:

1. **Insecticides**—Outside of a relatively large scale use in the treatment of shade and other ornamental trees, there has been very little use of insecticides in forestry practice in Kentucky. The use of insecticides for shade and ornamental trees is covered in another manual for pesticide operators.

2. **Fungicides** for the treatment of forest tree diseases have been little used. At this time it appears likely that use will remain small. Those fungicides employed in forest tree cultures have little effect on the immediate environment. Fungicides for shade and ornamental tree diseases are covered in another manual.

3. **Herbicides** used for the control of unwanted vegetation in Kentucky have not been present in large volume to date. Still, the use of herbicides has probably been greater than other pesticides and will likely continue to be the greatest pesticide use in forestry.

No single chemical or method of application is suitable for all forest or site conditions. Planning your program in advance of application will provide the most adequate control at the least cost per acre. One must assess a given site according to tree or brush size and number of stems to be treated, then choose the proper chemical and carrier, select the right method of application, and accurately evaluate the results later. The use of herbicides is recommended because they are economical, environmentally safe, effective, and versatile in application. The chemical response, or level of vegetation control obtained after application, will vary according to tree or brush size and density, the kind of herbicide, the volume applied, the carrier and the active ingredient, the season and method of application, species susceptibility, and the equipment being used. It is imperative that forest land managers, herbicide applicators, and particularly crew foremen familiarize themselves with these factors before application. They can then select the most suitable method or methods for their particular set of stand conditions. Next, READ THE LABEL AGAIN before applying the herbicides to be sure the correct formulation has been chosen and will be applied with the proper equipment at the right place at the right time.

Herbicides most commonly used for the establishment and improvement of forest stands are currently available under a variety of trade names. Many of these contain nearly the same chemical and concentration but with varying amounts of inert ingredients and carriers.

STORE PESTICIDES WISELY—Keep them out of reach of children, pets, irresponsible persons, and livestock. All pesticides should be stored under lock and key, outside the house, away from food, feed, seed, and fertilizers. Always store them in their original containers and keep them tightly closed.

AVOID PHYSICAL CONTACT WITH PESTICIDES—Never smoke, eat, or chew tobacco while handling or applying pesticides. Protect your eyes at all times. Avoid inhaling sprays or dusts. Do not spill pesticides on skin or clothing. Wash hands and face and change to clean clothing after using pesticides. Do not use your mouth to siphon liquids from containers or blow out clogged lines or nozzles. SEE YOUR DOCTOR IF SYMPTOMS OF ILLNESS OCCUR DURING OR AFTER THE USE OF PESTICIDES.

HARDWOOD INSECTS AND DISEASES

Except on ornamental trees, shade trees, and trees in high use recreation areas, very little use of insecticides or fungicides has been found necessary or considered economical for Kentucky hardwoods to date. Although several defoliators and other leaf feeders have been active, sometimes over large acreages, it has never been considered essential to control them.

Some examples of insects which have caused large scale foliar damage in recent years are the oak sawfly, locust leaf miner, magnolia snout beetle, and the forest tent caterpillar. Natural factors curbed the outbreaks of the snout beetle after only one serious year and tent caterpillar activity dropped off in two or three years. Foliar damage by the locust leaf miner and the oak sawfly occurs in mid to late summer after trees have made most of their annual growth. The oak sawfly, which attacks various species of red oak, greatly extended its area of activity in both 1974 and 1975; damage was apparent on perhaps 2 million acres of forest in southeastern Kentucky in 1975. This previously obscure insect has made a large impact since it was first noted in a few small isolated areas in 1973.

The greatest economic damage to hardwoods is caused by wood-boring insects of several families whose larvae bore tunnels in the living trees. These tunnels, up to one-half inch in diameter, cause degrade and heavy monetary loss when the trees are processed into lumber. At this time there is no practical way known of controlling these wood boring insects either with pesticides or with silvicultural practices.

CONIFER INSECTS AND DISEASES

There are a few insect and disease enemies of conifers which are well known. Because of the silvicultural effort that has been expended by agencies and individuals, especially in forest and Christmas tree plantations, there is a greater interest and incentive to have control measures applied to conifers than to hardwoods.

Diseases:

Annosus root rot (caused by Fomes annosus) is often found where partial cuttings or thinnings have been made in planted or natural pine stands. Also, scars on roots and stems caused by the passage of vehicles and equipment, as well as fresh cut stumps, provide infection centers for the disease. The conks, or fruiting bodies of the fungus, are usually found near the ground line, often completely covered by fallen needles and other debris. It may be necessary to scrape away the duff to find the fruiting body.

The fungus spreads from tree to tree by root contact and by wind-borne spores. Root systems of infected trees are gradually reduced to a stringy white mass of decayed wood. Infected trees are subject to wind throw. The disease spreads in a circular pattern from an infection center and most trees die within three years.

Fine granular borax dusted on the tops of stumps immediately after felling is effective in reducing the amount of annosus root rot.

Dothistroma needle blight (caused by Dothistromi pini) often attacks Austrian pine in Christmas tree plantations. Infected needles drop prematurely, leaving the trees unsuitable for Christmas trees. Early symptoms on the needles consist of yellow and tan spots and bands that appear

Fig. 1: Fruiting bodies of annosus root rot.

water-soaked. Commonly, the tips of the needles become chlorotic, then necrotic, with the base of the needles remaining green. Extensive necrosis may develop within three weeks after the first symptoms.

Two applications of Bordeaux mixture (8 pounds of copper sulfate, 8 pounds of hydrated lime, 100 gallons of water) during the growing season have given effective control. The first treatment in mid-May protects the old needles, and a second spray several weeks later protects the new ones.

Lophodermium needlecast is a relatively new, serious disease of scotch pine and red pine. It has killed millions of seedlings in tree nurseries in northern states in some years; it has been found on Christmas tree plantings in Kentucky.

Brown spots, often with yellow margins, are produced on needles in the spring from the previous year's infection. Fruiting bodies develop on the brown needles by June or July. By late August the mature fruiting bodies, shaped like tiny black footballs, are likely to be forcefully ejecting spores into the atmosphere. By late fall most of the dead needles are cast, leaving only the current-year needles and making infected trees unfit for Christmas tree use.

Three sprays for Christmas tree plantations and four for nursery infections are recommended for maximum control. The first spray should be applied before spore release and the following applications should be at 2 to 3 week intervals during major spore release periods. Two registered fungicides for this use in 1975 are chlorothalonil and maneb.

There are many nursery diseases which may offer special problems to seedling production of both conifers and hardwoods from time to time. These possibilities are too numerous to discuss here.

Insects:

The *Southern pine beetle (Dendroctonus frontalis)* attacks all of the hard pines and is a killer. Attacks are made on healthy trees of all sizes. This insect is the most destructive of the eastern species of pine beetles in the southern pine forests but has been an infrequent problem in Kentucky. During recent years, a major southern outbreak has been edging toward Kentucky, and in 1975 a large number of infection spots were discovered in southeastern Kentucky.

The southern pine beetle is a small, reddish-brown to black beetle about 1/8 of an inch long. The rear end of the beetle is rounded. Adult beetles bore through the bark of trees, mate, and the females excavate S-shaped egg galleries in the inner bark. The eggs hatch in four to nine days and mine through the inner bark. Small pitch spots or tubes are sometimes present. When a pine is attacked by large numbers of beetles, all of the needles turn yellow and then reddish-brown. This pest may have several generations a year.

Where practical, salvage operations should be undertaken. Proper timing of salvage cutting in the late fall of very recently dead and attacked trees (brood trees) may lessen the next year's population; however, these trees must be removed, and preferably milled, to lessen the population build-up. In some instances, spot infestations are treated by cutting all trees showing signs of attack and burning them. Chemical control may be obtained by thoroughly covering all logs and large limbwood; the logs must be rolled and the chemical (mixed in oil for penetration) applied until it begins to flow on the tree surface. Lindane is an example of an insecticide which has been widely used on pine beetles.

The *turpentine beetles* (two species) and several species of *Ips engraver beetles* are other bark beetles which, on occasion, cause considerable damage to pole and sawlog-size pine. Under normal circumstances, all prefer to attack weakened, unhealthy trees; however, fresh-cut stumps (for the turpentine beetles) and stumps and large debris (for the Ips) help attract and build up populations for successful attacks on living trees.

An Ips beetle attack is often confused with that of the southern pine beetle, but the adult Ips beetles have a "scooped out" rear end surrounded by a varying number of tooth-like projections. Control measures, where deemed necessary, are similar.

The turpentine beetles are larger insects and usually confine their attack to the lower 8 feet of the tree trunk. Large "pitch tubes" usually protrude as much as ¼ to ½ inch from the tree trunk. The beetles are about ¼ inch or more in length.

Several species of *pine sawfly* attack pine and sometimes have been very wide spread in Kentucky. They are particularly damaging to smaller trees, which often die when completely defoliated. All pine sawflies have caterpillar-like larvae that chew the needles. There may be one or more generations a year, depending upon the species. Control measures in plantations, particularly Christmas tree plantings, may be needed. The larvae are much more easily controlled when they are small. Methoxychlor is an example of an insecticide for sawflies.

Pine tip moths are especially injurious to the forms and shapes of trees in plantations, although this pest seldom causes mortality. In seed production orchards, the effect on flower and cone production is extremely important. Since the various species of tip moths attack the growing tip of the main leader and branches, the adverse effect on height growth is especially undesirable.

Eggs are laid on the foliage and, when they hatch, the yellowish to pale brown larvae bore into the bud. Feeding is within the buds and twigs. The larvae get to be about 1/3 inch in length, and the

brown pupae are often found within the damaged or dead branch tip.

Chemical control, to be effective against damage, must be applied in the late winter (February or March). This early spraying will not prevent later reinfestation, but it will destroy most of the existing population and make annual damage minimal. Cygon and dimethoate are examples of pesticides for tip moths.

Many pests such as *aphids* and *mites* may be a problem in forest tree nurseries and seed orchard areas, but are seldom necessary to control in forest conditions.

Fig. 2: Pine Sawfly caterpillar.

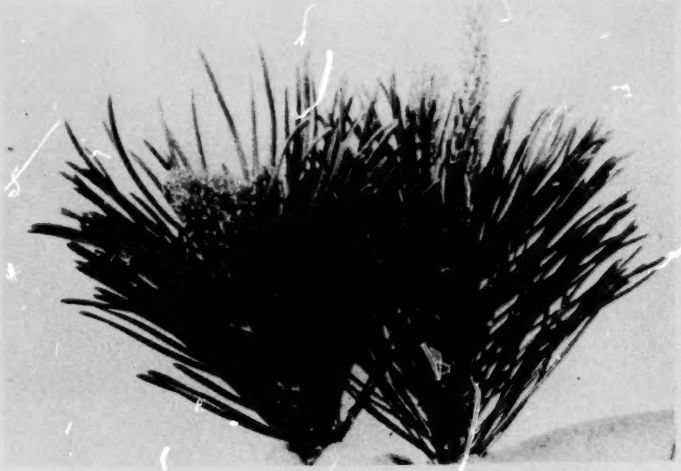


Fig. 3: The growing tip on the left has been damaged by the pine tip moth.

HERBICIDES

Perhaps the largest current and potential use of pesticides in Kentucky forests is for silvicultural purposes, to discourage unwanted growth and favor desirable individuals and species. To date most of the chemicals used in silvicultural practice have been the phenoxy herbicides such as 2,4-D, 2,4,5-T, silvex and related materials. Some of the more common uses of herbicides in forestry are:

SILVICULTURAL OBJECTIVE	HERBICIDE OBJECTIVE	TREATMENT METHODS AVAILABLE
Timber Stand Improvement (TSI)	To improve growth of desirable residual trees and create growing space for tree reproduction.	Frill girdle, tree injection, hatchet injection, and basal application.
Site Preparation	To control or set back existing competing vegetation before planting or seeding; or to increase browse value and create openings for wildlife.	Foliage spray applied with aircraft,* mist-blowers, backpack, or ground power pumps.

SILVICULTURAL OBJECTIVE	HERBICIDE OBJECTIVE	TREATMENT METHODS AVAILABLE
Pre-Commercial Thinning	To control stand density by chemical thinning of dense thickets of coniferous, hardwood or mixed stands that have not reached merchantable size.	Basal bark, tree injection, and hatchet injection.
Release of Conifers	Low release: from over-topping vegetation (competitors are low shrubs about same height as conifers or slightly taller).	Foliage spray (low volume) applied with aircraft or powered mist-blower, basal bark, and stump treatments.
	High release: from saplings or high understory (competitors are tall brush and low-value hardwoods taller and completely overtopping the conifers).	Foliage spray (low volume) applied with aircraft or powered mist-blower, basal bark, frill girdle, stump treatment, tree injection.
Release of Planted Trees Needing Special Treatment	To control grasses, weeds, and other competing vegetation around newly planted Christmas trees or walnut seedlings.	A directed spray applied by back-pack or ground power pump.

**Aerial application is covered under a separate pesticide manual.*

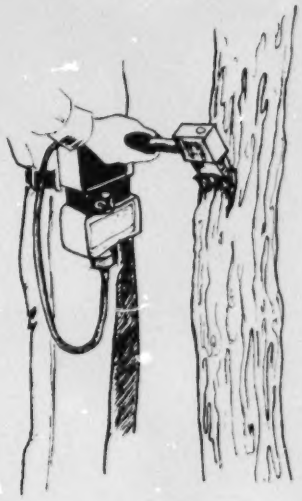
Herbicides may also be used around lumber drying yards and millyards to control vegetation which prevents the free movement of air around and through lumber stacks. Application is normally with ground sprays or soil treatments.

Methods of Application:

The following information is furnished for those who wish to have more detail about methods of herbicide application previously mentioned:

FRILL GIRDLE (continuous cuts)--Used for killing trees 5 inches in diameter and larger. A single line of overlapping downward axe or hatchet cuts is made completely around the trunk. Do not remove chips. Use an oil can with spout or squeeze bottle, pouring chemical into "frills" completely around the tree. Frills made 4½ feet above ground are convenient, but on species that are hard to kill, such as hickories, persimmon, and gums, the cuts should be made around the tree near the ground. Some chemicals which move both up and down in the tree are less affected by the height of the cut, but all are affected to some degree. Trees can be killed in any season with this method, but late spring, summer, and fall are best. This method does not work well on species such as maples during the spring, when heavy sap flow may wash the chemical from the frill.

INJECTOR (spaced cuts)—Use a special tree injector calibrated to deliver ½ to 1 ml of herbicide per cut upon impact, through the bark and into wood at base of the tree. Space the cuts 2 inches apart, or, if you have a difficult-to-kill species, cuts can be continuous. Undiluted formulations with more widely spaced cuts are also effective. Injectors can be used on all species, particularly 2- to 3-inch diameter trees, at any time of year, but May to August treatments are most effective.



HYPO-HATCHET (spaced cuts)—Apply incisions waist-high with a specialized hatchet-type tree injector. Apply 1.5 ml per cut, depending upon species and season. Useful in pre-commercial thinning of coniferous trees 8 inches in diameter and below. Effective on eastern hardwoods, especially beech, red maple and sugar maple. On hardwoods 8 to 16 inches in diameter, make cuts 3 to 6 inches apart around the circumference during any season, but summer and fall are best with spaced incisions.

STUMP TREATMENT—As soon as possible after cutting, spray or paint the flat stump surface with herbicide. Make sure that spray reaches the cambium and runs down the sides to the root collar. This treatment is very effective on species such as oaks, maples, beech, and hickories, which sprout profusely. However, expect poor root sucker control of black locust, sassafras, and sumac. A spray can be applied at any season but should be applied as soon as possible after cutting.

PROTECTING THE ENVIRONMENT

It is becoming creasingly important to understand the total impact of pest control activities on the forest and the adjacent environment. The need to minimize the possibility of secondary problems, such as unintended effects on wildlife, must be understood by the pesticide applicator.

1. Beneficial forest insects are represented by a great many species, some of which are very abundant. Some species feed on forest debris and aid in its deterioration, while others feed on organic matter in the duff and soil and contribute to improvements in soil fertility. Some contribute to stand improvement by attacking and killing declining, diseased, or over-mature trees and making way for younger growing stock. Many others are parasites or predators of destructive species of insects.

2. Biological magnification has resulted from the use of some insecticides for insect control on trees. It has been found that several species of animals are harmed by some pesticide chemicals. Worms, for example, form an important part of the diet of many aquatic species. Pesticides stored in the fatty tissues of some animals have been found to be passed along to higher forms of animal life when consumed.

3. The pesticide label is pehaps the most important guide to the use of a chemical; in fact, to use the material in a manner inconsistent with label directions is illegal. The label will provide information on the harmful effects that may occur on non-target species of wildlife such as fish and honey bees. Many spray and dust formulations should be applied during early morning hours or late afternoon when wind movement is very low. This will help prevent the drift of pesticides to adjacent food or feed crops or into lakes. Instructions for the use of special types of clothing to wear during applications will be included.

4. If there is a fish or wildlife kill in areas adjacent to pesticide applications, contact the appropriate agency, such as the Kentucky Department of Wildlife Resources, so they may investigate the reason for such kills. There are many other conditions that can kill fish and wildife that have no relationship to pesticides. Harmful conditions should be investigated in order to prevent future occurrences.

5. There are several meteorological factors associated with forest aerial applications that could cause environmental hazards. The drift of a long residual pesticide into adjacent lakes and streams is an example. However, most chemicals used for the control of forest pests in the southeast are applied with equipment which dispenses the chemical in close proximity to the target pest.

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